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## (54) FLUORESCENT PLASTIC LIGHT SOURCE

(71) We, FORD MOTOR COMPANY LIMITED, of Eagle Way, Brentwood, Essex CM13 3BW, a British Company, do hereby declare the invention for which we pray that 5 a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to devices incorporating liquid crystal displays (LCD's). 10 The invention is particularly, but not exclusively applicable to clocks with LCD read-out for use in motor vehicles, and in preferred forms incorporating an interior light for 15 the vehicle.

Clocks incorporating LCD's are well-known, but have the disadvantage that the display contrast when relying on ambient light is poor. This is particularly the case 20 with a clock mounted for reading by the driver of a vehicle, since the light level in the vehicle interior is fairly low while the driver's external view is often at a relatively high level of illumination.

25 It has been proposed to enhance display contrast by placing a sheet of transparent material incorporating fluorescent molecules behind the LCD; see e.g. "Electronics", June 9th, 1977, pp. 3E and 4E. 30 However, this still relies on ambient light incident from the viewer's position and is not well-suited to automotive applications.

According to the present invention there 35 is provided a display device comprising a housing having spaced front and rear surfaces, a liquid crystal display positioned within the housing to be viewed through an aperture in the front surface thereof, a sheet of transparent material incorporating a 40 fluorescent dye positioned behind the liquid crystal display and having optically reflecting surfaces except for light-diffusing portions behind character portions of the liquid crystal display, means for coupling to the 45 interior of said sheet ambient light incident

towards the rear surface of the housing, and a light source operable to introduce light into said sheet when no ambient light is available.

Embodiments of the invention will now 50 be described, by way of example, with reference to the accompanying drawings, in which:—

Figure 1 is a perspective view of combined clock and interior light for a vehicle, 55 embodying the invention;

Figure 2 is an underneath plan view of the assembly of Figure 1;

Figure 3 is a diagrammatic cross-section 60 of the same assembly;

Figure 4 is a similar cross-section of an alternative embodiment; and

Figure 5 shows one form of electrical circuit for use with the above embodiments.

The clock/interior light assembly is 65 designed to be mounted to the roof of a vehicle passenger compartment in the orientation shown in Figure 1. A housing 10 has a first portion 10a depending from the roof. The front surface (as viewed by the driver) 70 of the housing portion 10a is apertured to reveal an LCD clock display 12. A second housing portion 10b mounts an interior light lens 14, a three-position rocker switch 16, and pushbutton switches 18.

75 The display 12 may be any known LCD clock display. Preferably it comprises a cell containing twisted nematic liquid crystal material and provided with four digits of seven-bar electrode formations, polarising 80 films being provided to the front and rear of the cell. As is well known, this results in a bright read-out against an opaque background.

As seen in Figure 3, a sheet 20 of plastics 85 material is placed against the rear face of the LCD display 12. The sheet 20 is suitably of acrylic material such as "Perspex" (Registered Trade Mark) doped with fluorescent organic molecules of the fluorescein class. 90

The surface of the sheet 20 adjacent the display 12 is engraved or etched in its areas backing the digit display areas of the display 12; otherwise the sheet 20 has smooth surfaces. A printed circuit board 22 is mounted behind the sheet 20 and carries a known clock and display driving circuit.

The rear surface of the housing portion 10a is provided with a window 24 which in use faces towards the vehicle windscreen 26. A cut out portion (not seen) of the printed circuit board 22 permits light passing through the window 24 to fall on the sheet 20. The organic molecules are excited by the incident light, and the resulting fluorescent light is mainly trapped within the sheet 20 by internal reflection. However, light may escape through the engraved areas behind the display digits, and thus the available light is concentrated to pass through the display.

For use in darkness, the clock is provided with a light source, in this embodiment a lamp 28 arranged to couple light into the lower edge of the sheet 20 and provided with a shield 30 to prevent light from passing through the window 24. Alternatively, the light source could be a light emitting diode secured directly to the sheet 20.

The embodiment shown in Figure 4 is similar, and like references denote like parts. In this embodiment, however, the window 24 in the housing is omitted. The sheet 20 receives daylight through the windscreens 26 by means of its protruding through the lower edge of the housing 10. The protruding portion of the sheet 20 is formed with an angled surface 32 which is silvered to direct light incident through the windscreens 26 into the interior of the sheet 20. The light source 28 is arranged to couple light into a major face of the sheet 20.

The pushbutton switches 18 (Figure 2) are used to set the clock in known manner. The rocker switch 16 is used to control the clock/light unit as will now be described with reference to Figure 5. The clock circuit 22 is connected across a vehicle power supply line 34 and vehicle earth. The interior light 36 is connected between the supply line 34 and one gang of the switch 16, and the clock light source 28 between the supply line 34 and the other gang of the switch 16. A door-operated switch of known type is connected to poles 1 and 3 of the first gang, pole 2 being connected to vehicle earth. On the second gang, pole 3 is earthed and the other two are open circuited.

Thus, with the switch 16 in position 1, the interior light 36 is controlled by the door switch and the clock illumination is off. In position 2, the interior light 36 is on. In position 3, control of the interior light 36 reverts to the door switch but the clock light source 28 is illuminated.

Other possible wiring arrangements will be apparent. For example the clock illumination could be controlled automatically by a light sensor in conjunction with the vehicle ignition switch to be on whenever the ignition is on and ambient light is low; or the clock illumination may be wired in circuit with the vehicle sidelights.

#### WHAT WE CLAIM IS:—

1. A display device comprising a housing having spaced front and rear surfaces, a liquid crystal positioned within the housing to be viewed through an aperture in the front surface thereof, a sheet of transparent material incorporating a fluorescent dye positioned behind the liquid crystal display and having optically reflecting surfaces except for light-diffusing portions behind character portions of the liquid crystal display, means for coupling to the interior of said sheet ambient light incident towards the rear surface of the housing, and a light source operable to introduce light into said sheet when no ambient light is available.

2. A device according to Claim 1, including a clock circuit within the housing connected to drive the display.

3. A device according to Claim 1 or Claim 2, in which the housing also contains a light and is provided with a lens for the light for illuminating a space exterior of the housing.

4. A device according to any preceding claim, in which said coupling means comprises a window in the rear surface of the housing.

5. A device according to any of Claims 1 to 3, in which said means comprises a portion of said sheet protruding beyond the housing.

6. A device according to Claim 5, in which said protruding portion is provided with a silvered reflective surface.

7. A device according to claim 2 or any claim dependent thereon, in which said circuit is mounted on a circuit board and the circuit board, sheet and display are secured together.

8. A device according to any preceding claim, in which the liquid crystal display comprises a cell containing a twisted nematic material sandwiched between polarising films.

9. A display device substantially as hereinbefore described with reference to the accompanying drawings.

PETER ORTON  
Chartered Patent Agent.

1540965

COMPLETE SPECIFICATION

2 SHEETS

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the Original on a reduced scale.

SHEET 1

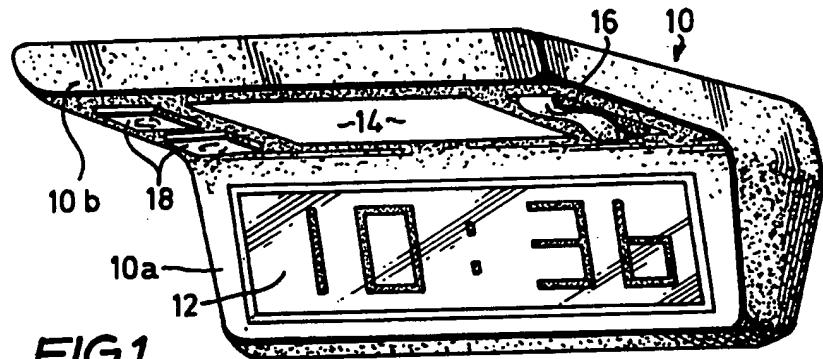


FIG.1

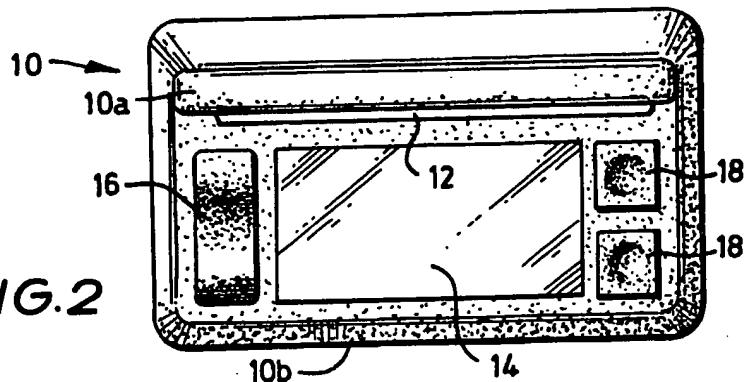


FIG.2

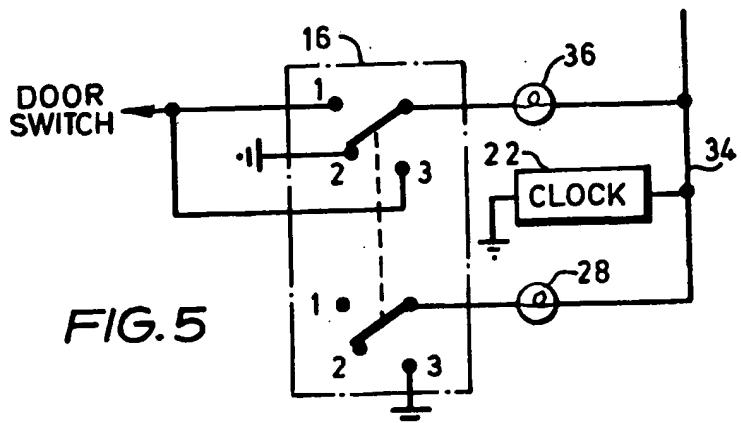


FIG.5

1.540965 COMPLETE SPECIFICATION

2 SHEETS

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SHEET 2

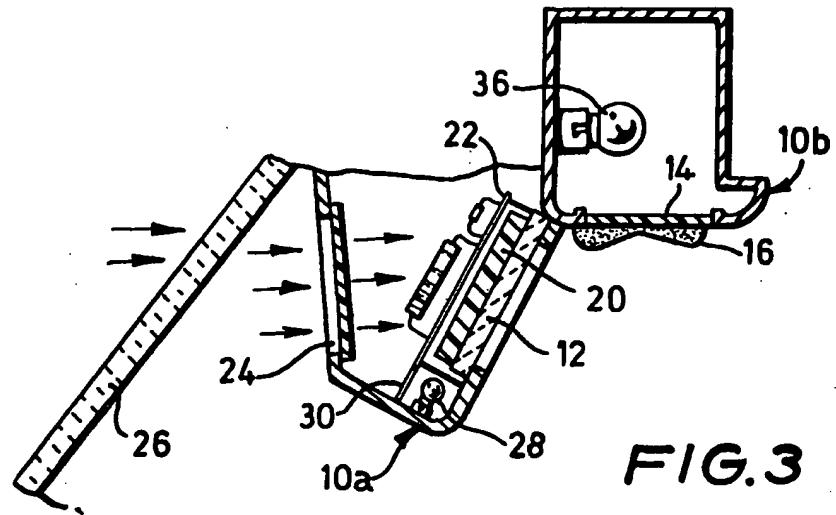


FIG. 3

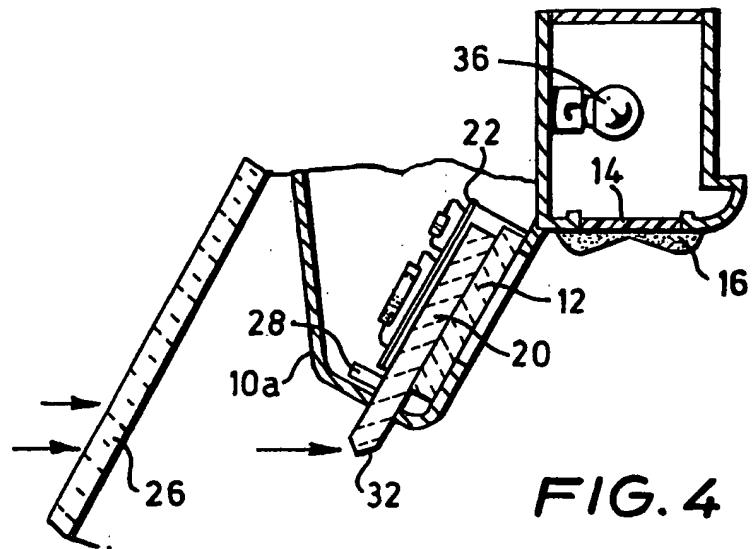


FIG. 4